Evaluation of Selected Israeli Rootstocks for Productivity and Dwarfness under Different Stress Conditions

Continuing Project; Fourth Year

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Introduction

Selection of resistant rootstocks for fruit trees is a painstakingly time consuming process. It requires long-term selection work, under different field conditions. On the other hand, it is the shortest way to get practical solutions to soil problems (like diseases and salinity). *Phytophthora cinnamomi* and salinity are the major problems facing the avocado plantations. During the last few years there is a severe reduction in water quality in Israel. Thus, avocado orchards are exposed to increasing salinity and unareated conditions. It has to be emphasized that due to the increase in the average yield (15 - 20 ton per hectare, instead of 7-10 t/h, several years ago); the management of the orchards has been totally changed. Increased water supply per hectare leads to increases in accumulation of chlorine, nitrogen and boron, up to toxicity levels. In the commercial orchards, it is observed that as the rootstocks get more resistant the yield are shown to be relatively higher.

The aim of this research is to evaluate different rootstocks under salinity and *Phytophthora cinnamomi* conditions. During the juvenile growth period, the evaluation was concentrated on various horticultural parameters, like trunk circumference growth, leaf burns etc'.

Material and Methods

The research is carried on in three experimental orchards: Two **existing plots**, which include part of the tested rootstocks. They were established in spring 1996 at **Mishmar–Haemek** (heavy soil, *P. cinnamomi*). The rootstocks were grafted with Hass variety in the spring of 1999. The second plot is located in **Kfar Hogla** (Light soil and poor water quality). The rootstocks are grafted with Reed and Hass variety (Table 1). Horticulture surveys (Tree growth, leaf-burns, trunk circumference and blooming rates) were measured during 2000 - 2001. No *P.cinnamomi* symptoms were yet traced.

One new plot: A total of 12 different rootstocks were planted in the Northern Galilee, in Idmit, characterized with heavy soil, high quality irrigation water (100 mg. Cl/l), presence of *P. cinnamomi*, and cold weather conditions (Table 1). They were planted in the space of 6 x 4m. The tested rootstocks include the West Indian and the Mexican races. These rootstocks were planted in this new plot, in June1999 (as ungrafted rootstocks). All rootstocks were grafted with Hass variety during late summer of 2000. Unfortunately, most of the grafts failed due to professional inability of grafter. He claimed the rootstocks as seedlings and not as vegetative clones so all the grafts on the VC rootstocks failed. All the vegetative rootstocks were grafted again by July 2001. The new grafts succeeded with a very high ratio. (We had to wait such a long time before re-grafting, due to religious reasons. This year is a "Shmita-year" meaning that we are not religiously allowed to have new plantations, grafting and pruning and leave all agricultural land to follow. This happens once in every seventh year between the 2 new Jewish Year dates. This year between September 2000 and September 2001. Recently we got permission from another "Rebi", who agreed to permit us to renew the failed grafts. It is important that the farmers follow the religious rules in order to sell the coming seasons fruit through the packinghouse). For a better pollination of Hass, the Etinger variety was grafted on West Indian Rootstock, Degania 117, each 4th row. Most of the grafts succeeded. All along the coming years, the Hass and the Etinger will be analyzed separately.

The Gordinco group was already canceled from the experiment. New seedlings of Zriffin99 grafted with Hass were replanted instead of the declined group (Pic.1).

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Table 1: A list of rootstocks included in the experimental plots:

Rootstock	Race	Test	Plot	Location	Budwood
		Idmit	M.H.*	K.H.**	UCR***
Vc28	W.I.	+	+	+	+
Vc55	W.I.	+	+	+	
Vc66	W.I.	+	+		+
Vc207	W.I.	+	+	+	
Vc256	W.I.	+	+	+	
Vc265	W.I.	+			+
Vc801	W.I.		+	+	
Vc802	W.I.		+		+
Vc803	W.I.	+			+
Vc804	W.I.	+			+
Vc805	W.I.		+	+	
Vc806	W.I.		+	+	
Vc820	W.I.		+		
Vc821	W.I.		+	+	
Vc49	Mex.	+		+	+
Vc239	Mex.	+			
Vc828 (Duke7)	Mex.	+			+
Ashdot 17 (s)	W.I.	+			+
Degania 117 (s)	W.I.	+			

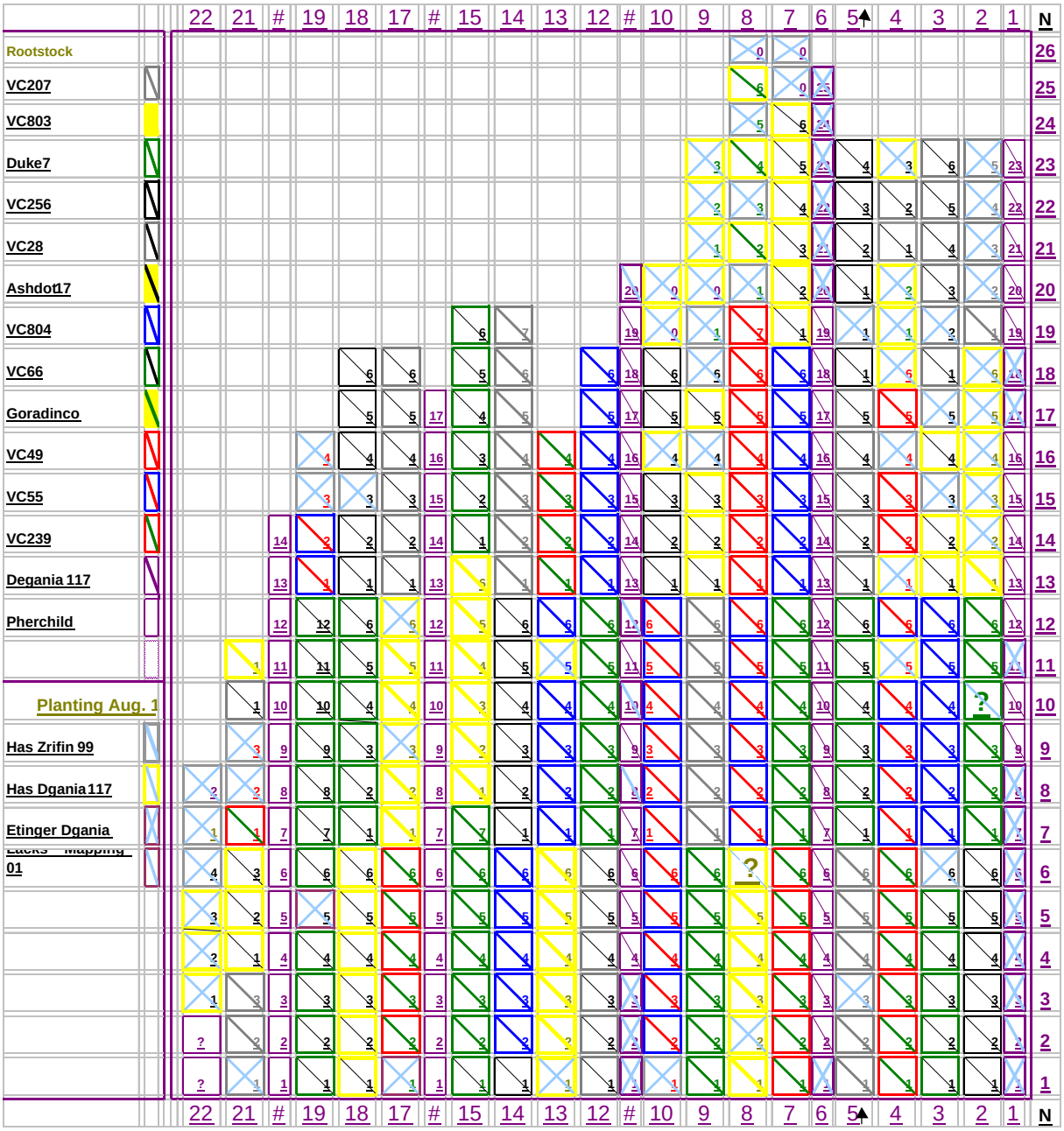
*M.H. : Mishmar Haemek.

**K.H.: Kfar - Hogla.

***These rootstocks were sent to California during the last few years.

(s) - seedling

Picture 1: Planting Map, Idmit 1999-2000



Weed control: The weed population in this plot is biased mainly on the *Bides tripartite* L., belongs to the *Composite* family, sub. family *Tubuliflorae*. This plant is considered in Israel as a problematic weed; while in South-Africa and California it is a very mild weed. Since we noticed the damage of Roundup (Glyphosate) to the young trees, in other commercial orchards, this experimental plot was treated manually with Diquat. The weeds in the other plots are cutt down by lawn.

Results

Horticultural surveys (Tree growth, leaf-burn, Chlorosis) were undertaken during late summer 2000. The results show differences between the rootstocks, especially between the West Indian and the Mexican ones (Tab. 2). The most interesting information for this year was the horticultural growth rate, the differences between the growth potentials of each of the rootstocks. These results are preliminary, since the data collected from the ungrafted rootstocks.

Table 2: Phonological surveys of different rootstocks. "Idmit"(late summer and autumn 2000).

Rootstock	Leaf-burns (0 - 5)[w]	Chlorosis (0 -2)[x]	Trunk circumference increase (cm.)[y]	Horticulture survey (0 - 4)[z]
Vc207	**0.32** ± 0.67	**0.39** ± 0.92	**4.71** ± 2.08	**1.96** ± 0.94
Vc803	**2.63** ± 1.33	**0.37** ± 0.76	**4.00** ± 2.93	**1.63** ± 0.93
Duke7	**2.72** ± 0.75	**1.14** ± 0.99	**5.94** ± 1.93	**2.68** ± 0.75
Vc256	**0.52** ± 0.64	**0.15** ± 0.46	**6.12** ± 1.95	**3.14** ± 1.08
Vc28	**0.34** ± 0.61	**0.21** ± 0.49	**4.42** ± 2.96	**2.50** ± 0.95
Vc804	**0.97** ± 1.05	**0.24** ± 0.58	**4.18** ± 2.70	**3.00** ± 0.53
Vc66	**1.14** ± 1.03	**0.34** ± 0.84	**5.82** ± 2.55	**2.61** ± 0.93
Vc265[a]	**2.75** ± 0.96	**0.35** ± 1.00	**0.67** ± 0.58	**0.50** ± 0.53
Vc49[a]	**2.83** ± 0.94	**1.58** ± 1.44	**6.00** ± 2.83	**2.23** ± 1.30
Vc55	**1.36** ± 1.16	**0.68** ± 1.09	**3.83** ± 2.39	**2.18** ± 1.02
Vc239	**3.24** ± 0.89	**0.67** ± 1.06	**6.41** ± 2.32	**3.04** ± 1.21
Ashdot17	**0.31** ± 0.55	**0.04** ± 0.2	**3.82** ± 1.71	**1.77** ± 1.03

[w] Leaf burn scale 0-5: 0- no leaf burn, 5-all the leaves are totally brown.
[x] Chlorosis scale 0-2: 0- green leaves. 2- full yellowish leaves.
[y] Trunk circumference - additional increases in one year (between October 1999 to September 2000).
[z] Horticulture survey scale 0 - 4: 0 - dead tree, 4 – a vigorous tree**.** [a] - Most of the trees had been declined.

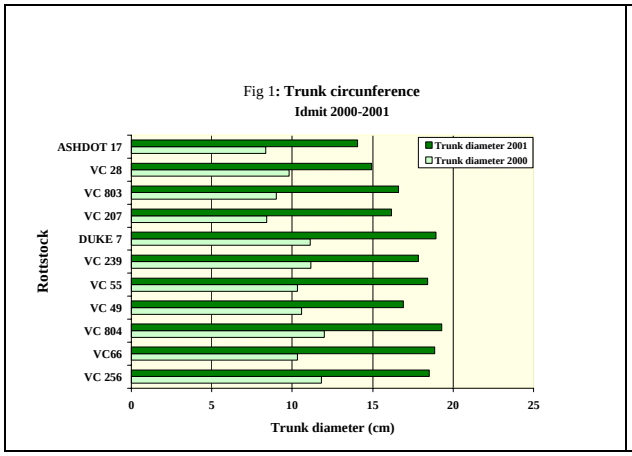
The above surveys have been undertaken one and two years after the plantation, just before the first grafting. One of our surveys shows the rate of saplings that didn't survive. In table 2 we see that only few trees of the two Mexican rootstocks: VC 49 and VC 265 - Gordinco, survived. It seems to be due too heavy and un-aerated soil but can also be due to the relatively high salinity of the irrigation water. No *Phytophthora cinnamomi* infestation was isolated from the roots of the dead trees. Except these two groups, most of the trees (87.2%) established well in the soil, and were grafted during late summer 2000.

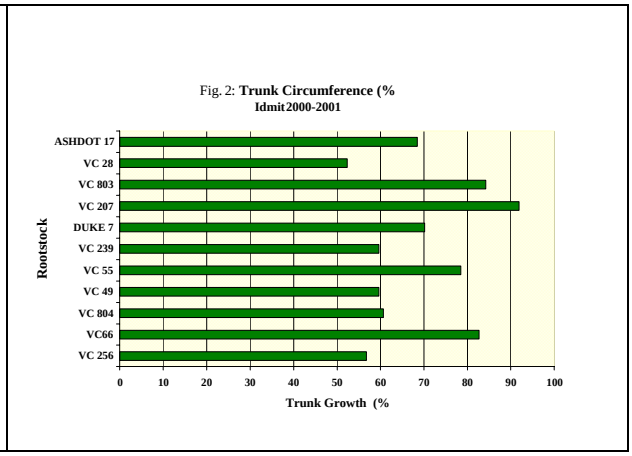
The two horticultural parameters considering the tree growth rate (according to the following scale: 0 – no growth, 4 – vigorous growth) and additional growth in trunk circumference, in one year (between October 1999 to September 2000) show similar tendency (table 2). The two rootstocks: VC256 and VC239 show the biggest growth rate at both measurements, while VC55 and VC803 are the weak ones, except the Gordienco. VC66 should be mentioned as a strong rootstock in the tree circumference growth but less in the whole horticultural scale.

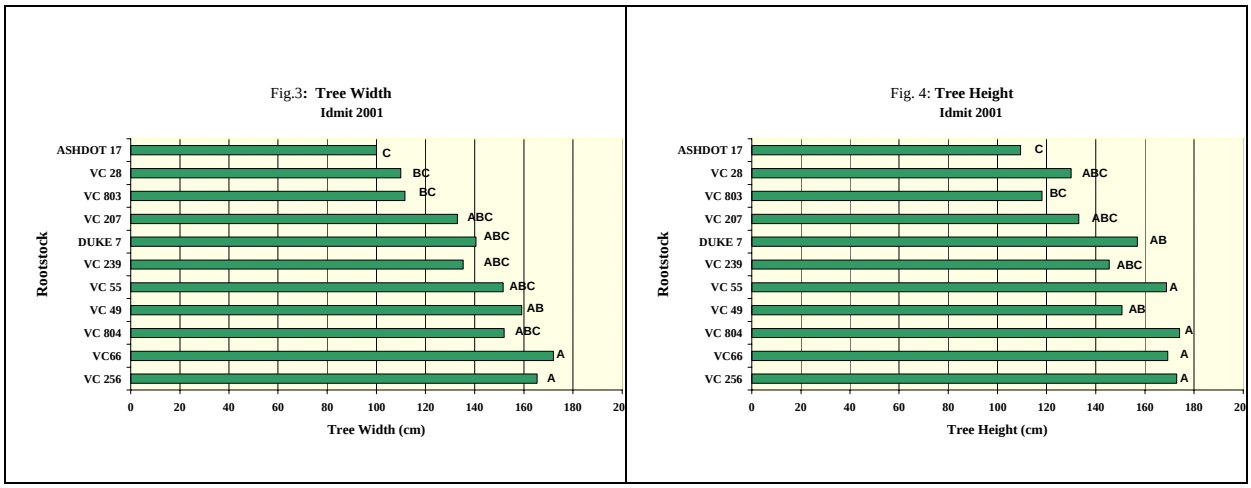
The next surveys were undertaken nine months later. The trunk circumference measured in July 2001 (still on ungrafted trees because of the technical failure in grafting, as explained above) shows no significant differences between the vigor rate of the rootstocks (fig. 1). All the same it has to be mentioned that although the statistical show no significant differences in tree circumferences, still there is a differentiation trend in the additional trunk circumference between group of 5 rootstocks (VC207, VC803, VC55, VC66 and Ashdot17) and the other 6 rootstocks. Fig. 2 demonstrates very clearly the additional growth rate of the last year. The two Mexican rootstocks, VC239 and the few remaining trees of VC49, didn't grow as much as the year before. It can be evaluated as the first symptoms of salinity(?). Also VC256 was not the most vigorous one this year, as the year before.

The explanation to the non-significance in the results is based on the large numbers of rootstocks that are involved in the experiment. Since the scattering between the highest value and the lowest one is large, and the number of treatments (= rootstocks) is high, we need a higher significance level for clear decision.

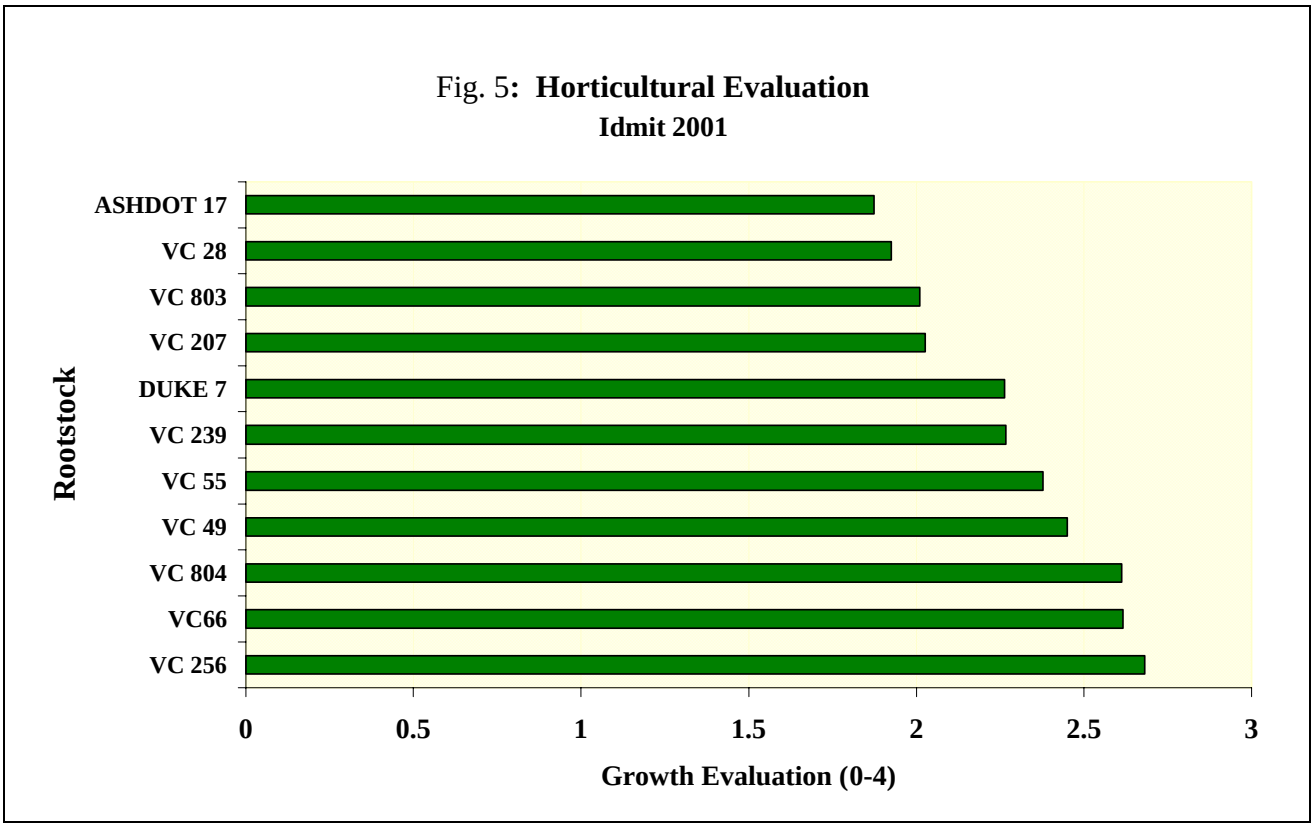
The tree width and height are other growth parameters. In this experiment, since the rootstocks are very different in their botanic resources, it can also describe the scion-growth habit. The data represented in fig.3 and fig.4 drawn gives a nice picture: rootstocks with low growth in width have also low growth in height.







The latest horticultural survey (according to the scale 0 - 4: 0 - dead tree, 4 – a vigorous tree) was taken during May 2001. At this time all the trees reached the rate between 2 - 2.8, which means not very vigorous trees on average (fig. 5). The reason for this may be attributed to the timing that the trees had not yet overcome the winter. The new shoot and leaf growth was a bit later and good. Still, these results are only preliminary, since these surveys have been collected from the ungrafted rootstocks.



Mineral content in the leaves:

Leaf sampling was done at the end of July, a little earlier then the usual instructions in Israel. But as in this case, where there are no salinity problems expected, sampling can also be done at the end of the summer. The data represented in figures 6 - 14 represents the mineral content in the leaves of the various rootstocks. The equal level of **Ca+** concentrations in the leaves point out that the leaves sampled were at the same phonological age (fig 9). On the other hand, it is shown that there is heterogeneity between the different rootstocks. Some clear differences are shown with **Na** in Ashdot 17 or Dgania117 that has high level of Sodium (fig.10). Also with **microelements** there are clear differences between rootstocks (fig 12,13,14). Zinc concentration in the VC28 is very conspicuous in relation to the other rootstocks (fig.13). Considering **Boron,** there is an important variation in concentrations between the various rootstocks (fig.11). The question is whether this is related to resistance to Boron. This information will be collected in the future. It should also be taken into account that more years of sampling and analysis are needed to define the characterization of the different rootstocks in absorbing elements.

Fig. 6: **Nitrogen in rootstock leaves**
July 25/7/2001

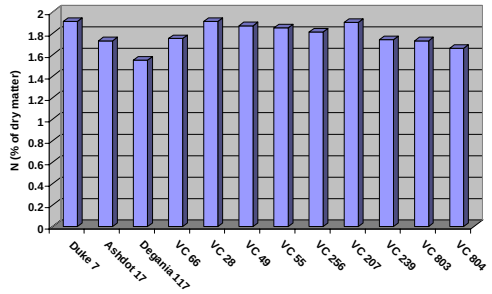


Fig. 7: **Phosphorous in rootstock leaves**
July 25/7/2001

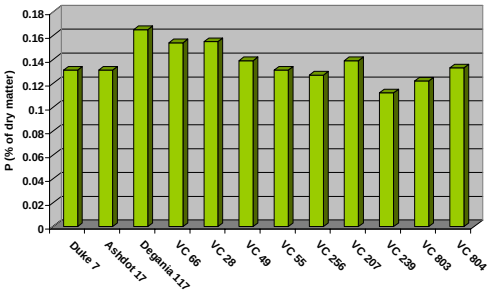


Fig 8: **Potasium in rootstock leaves**
July 25/7/2001

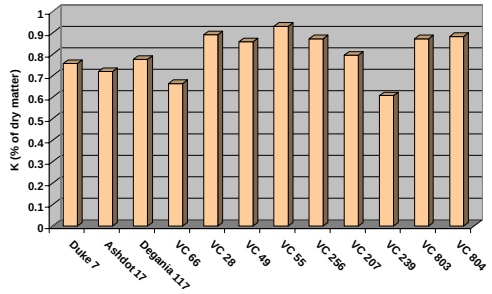


Fig. 9: **Calcium and Magnesium in rootstock leaves**
July 25/7/2001

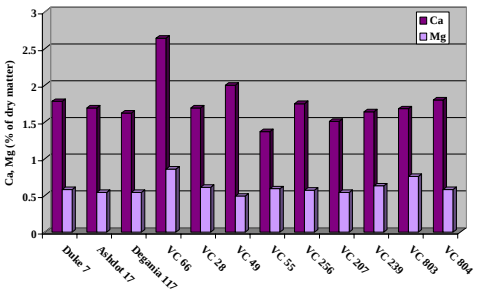


Fig. 10: **Sodium in rootstock leaves**
July 25/7/2001

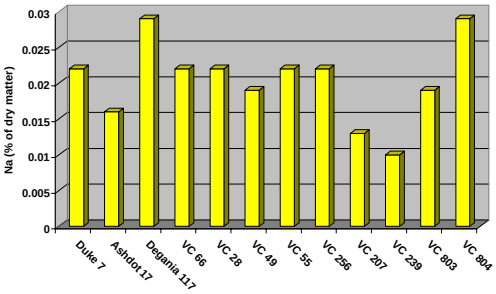
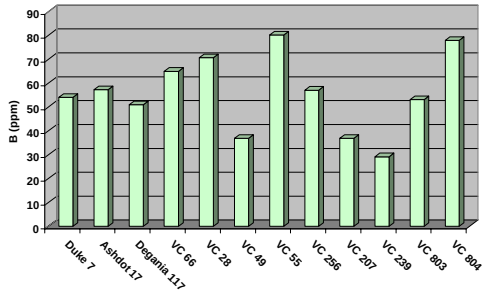


Fig. 11: **Boron in rootstock leaves**
July 25/7/2001



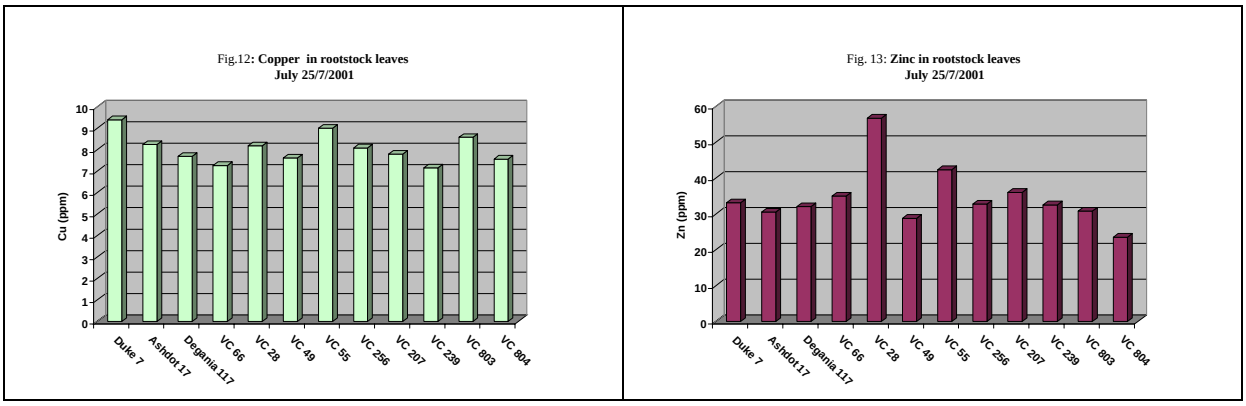
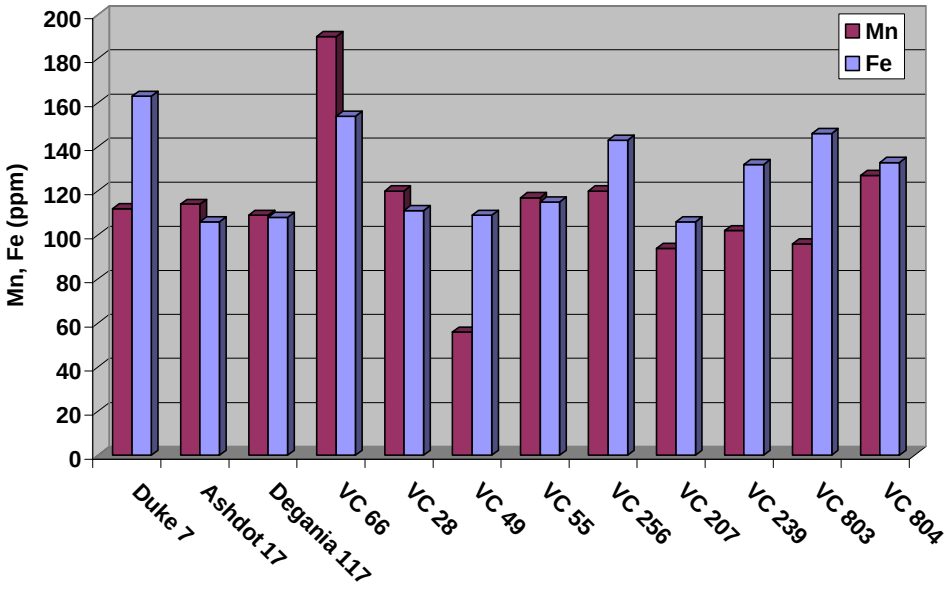


Fig. 14**: Manganese and Iron in rootstock leaves**
July 25/7/2001



Leaves from the Goradinco rootstock were not sampled since there were only 2 trees left, and they were unfit.

Kfar Hogla:
Testing the rootstocks in different distant growing areas in Israel enables us to achieve wide and major information about these rootstocks. That is the reason why we included other plots in different parts of Israel.

The plot in Kfar-Hogla is located in the central part of Israel. It was planted in the year 1996, on sandy soil with poor quality irrigation water: 250 mg Cl/l, EC: 1.35 dC/m. In the region Mediterranean coastal climate, prevails with an average rainfall of 19.7". The rootstocks are grafted with Reed and Hass variety (Table 1). Horticultural surveys (Tree growth, leaf-burn, trunk circumference and blooming rates) were undertaken during 1999 - 2001. No *P.cinnamomi* symptoms have been shown yet.

The trees are healthy and vigorous. No leaf-burn or chlorosis symptoms are seen on the leaves. The growth rates of the trees for the years 1999 - 2001 have been measured through trunk circumference. Comparing the growths in the two last years we can say that the growth rate has comparably slowed in the last year. This can be explained by the production, since this year has been the first year of commercial fruit bearing.

Table 3: Phonological surveys of Hass grafted on different rootstocks.
"Kfar-Hogla" 1999 – 2001

Rootstock	Relative yield assessment* 2001	Additional trunk circumference (cm.) 1999-2000	Additional trunk circumference (cm.) 2000-2001
Vc28	2.5	9.7	5.7
Vc55	3.7	6.1	4.7
Vc207	3.7	4.4	5.0
Vc256	3.2	9.0	5.1
Vc801	3.8	8.0	4.5
Vc805	3.1	9.0	5.3
Vc806	2.8	7.3	5.0

* Relative yield assessment: scale 1 - 5: 1 - few fruits on the tree, equivalent to 2 t/ha yield, and 5 – a heavy yield, equivalent to 20 t/ha.

Summary

The limiting factors to avocado production are *Phytophthora cinnamomi* and salinity. The strategy to overcome these problems is the use of resistant rootstocks, that have been selected for their high yields under these stress conditions. The West-Indian race is used as the basis of avocado rootstocks in Israel. They tend to have a high resistance to *Phytophthora cinnamomi* and salinity. A few Mexican rootstocks that are known for their high resistance to *P. cinnamomi* were also selected. Since the Mexican race is used as the basis of avocado rootstocks in California, it is important to include Mexican rootstocks in the selections. We believe that the selected West Indian and Mexican rootstocks from Israel can be adapted for commercial use in California after further field evaluation for a final selection.

Research for 2002:

Continuation with the trunk circumference monitoring, and analysis of xylem water as an indicator of current chloride uptake status in trees, collecting yield data, leaf analyses, etc'. More over, we intend to search more deeply the physiological differences between the rootstocks. This is planned to be accomplished by using the "Phytec", a new computerized phytomonitoring technique that enables to collect relevant information on the physiological status of the trees.